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Santa Clara Valley Water District

Groundwater Conditions 74-75

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SANTA CLARA VALLEY WATER DISTRICT

ANNUAL SURVEY REPORT ON GROUNDWATER CONDITIONS

by

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April 1976

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SUMMARY OF 1974-75
GROUNDWATER CONDITIONS

The volume of groundwater in storage increased in Santa Clara County during the water year July 1, 1974 through June 30, 1975. With just below-average rainfall, 1974-75 ended showing increases of groundwater in storage of 20,000 acre-feet in the Santa Clara Valley Groundwater Basin, 4000 acre-feet in the Coyote Groundwater Basin, and 7000 acre-feet in the Llagas Groundwater Basin.

During this same period, the District imported 104,052 acre-feet of water through the South Bay Aqueduct. The Rinconada Water Treatment Plant treated 51,900 acre-feet of this water and the new Penitencia Water Treatment Plant, which began operation in July 1974, treated 15,500 acre-feet. The 20-mgd Penitencia Plant supplies treated water to the east side of North Santa Clara Valley. The District has requested 100,000 acre-feet from the State for the 1976 calendar year.

No land subsidence was detected in 1974-75. Subsidence has been effectively halted since 1969 because groundwater levels have risen above and have remained above the critical pressure elevation. Flowing artesian wells reappeared for a short time in the Alviso area after a more than 30-year absence.

Groundwater continues to be high-quality water usable for all beneficial purposes. However, certain localized areas have yielded groundwater of poor mineral quality. Inspection of groundwater chloride-concentration data indicates that the limits of saltwater contamination in most places have not changed significantly during the period 1949 through 1972.

INTRODUCTION

This is the annual report on groundwater conditions in the three major groundwater basins of Santa Clara County for water year 1974-75 which extends from July 1, 1974 to June 30, 1975. The purpose of this report is to inform the District Board of Directors and interested citizens of the current condition of the groundwater basins. The three major groundwater basins, which are interconnected and occupy nearly 30 percent of the total county area, are the Santa Clara Valley, Coyote and Llagas Basins, shown on Plate 1. Groundwater supplies nearly 49 percent of the total water used in the Santa Clara Valley Basin and nearly all of that used in the Coyote and Llagas Basins. The remainder is supplied from local surface diversions and import sources.

Zones of benefit have been established for the conservation, importation, treatment and distribution of water used in Santa Clara County and are shown on Plate 1.

Zone W-2 encompasses the Santa Clara Valley Groundwater Basin and was formed for the registration of those groundwater producing facilities that benefit from recharge of the groundwater basin by the District with local and imported water. In this zone, a charge is levied for groundwater extracted and the revenue thus derived is used to support the District's conservation and importation program. Major sources of water supply income are the groundwater charge levied in Zone W-2 and the sale of treated water. The groundwater charge for nonagricultural uses during 1974-75 was $30 an acre-foot, and for agricultural uses the groundwater charge was $8 an acre-foot. Treated water was sold

at $65 an acre-foot, with water in excess of contracted amounts sold at $38 an acre-foot.

Zone W-4 encompasses all of Zone W-2 plus the lands of water consumers outside of Zone W-2 that use or otherwise benefit from locally conserved water and from the importation and distribution of water from the South Bay Aqueduct. In this zone, a property tax rate of $.018 per $100 of assessed valuation was levied to pay for the cost of water purchased to recover the accumulated overdraft in the groundwater basin, control land subsidence, and sustain an emergency supply of water.

In Zone W-3, comprising most of the Coyote Basin, an ad valorem tax of $.370 per $100 of assessed value (on land only) was levied in lieu of a groundwater charge. The subzones within Zone W-3 were formed for the purpose of assessing a groundwater charge on pumping facilities that export water from the Coyote Groundwater Basin to areas outside of Zone W-3. No groundwater charge was levied in the Llagas Basin.

HYDROLOGIC BALANCE

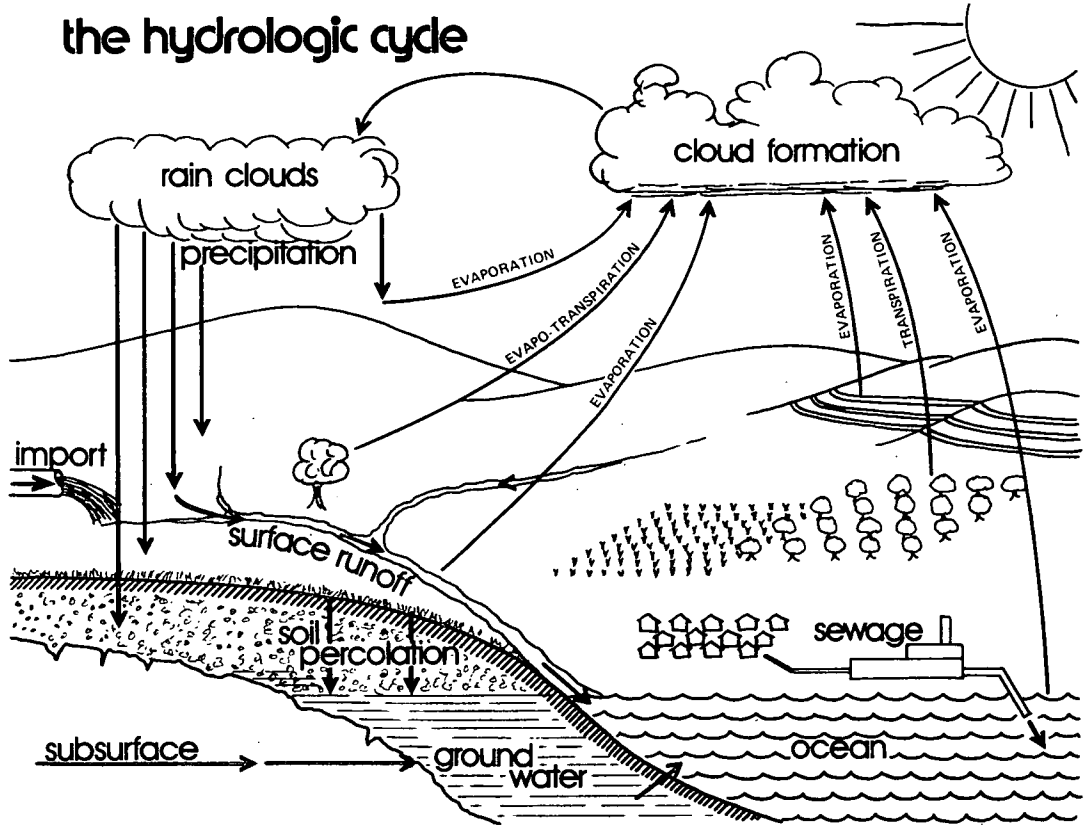
Rainfall was slightly below average for the Santa Clara Valley in 1974-75, 13.50 inches being recorded at San Jose which averages 14.14 inches and 18.37 inches being recorded at Gilroy where 19.96 inches is average. Except for Lexington and Guadalupe, all reservoirs filled to capacity with the help of carryover storage from previous years. Each of the three groundwater basins experienced increases in the volume of water in storage.

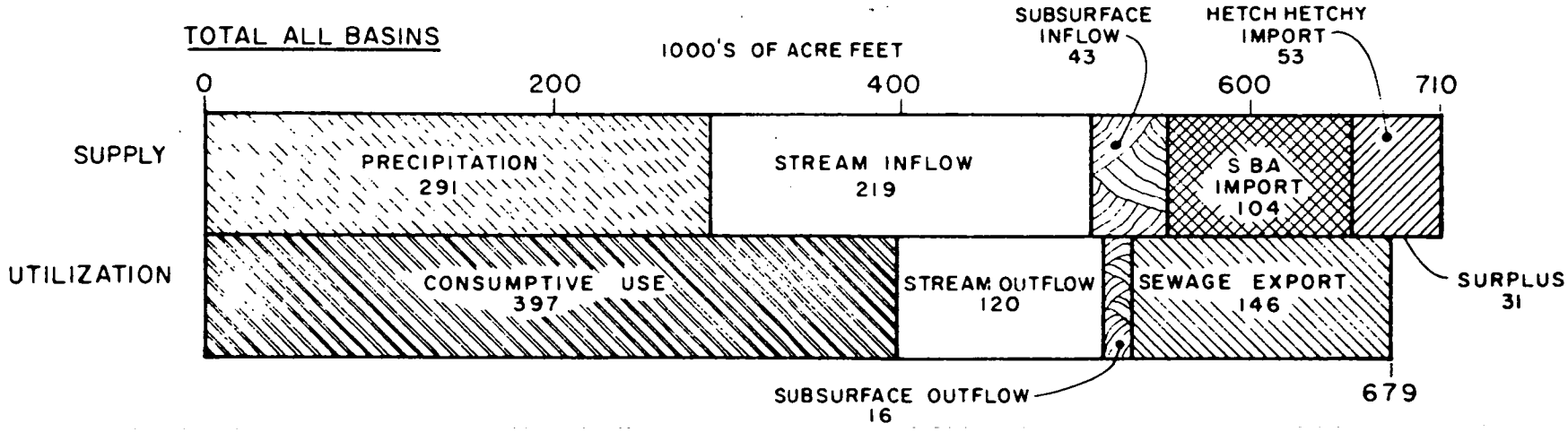
The volume of water in storage changes as water levels rise and fall. In a groundwater basin, this change of stored water in the unconfined zone can be computed by multiplying estimates of the storage capacity for the aquifer materials by the area and by the change in depth between groundwater levels at the beginning and end of the season (Plate 3). This year increases of 23,000 acre-feet in the Santa Clara Valley Basin, 2,000 acre-feet in the Coyote Basin and 7,000 acre-feet in the Llagas Basin were computed.

These estimates were checked by balancing the hydrologic components of water supply and utilization. Water supply consists of precipitation, stream inflow, imported water and subsurface inflow. Water is utilized or lost by consumptive use, sewage export, stream outflow and subsurface outflow. The difference between supply and utilization is the net surplus or deficit of water in storage in the groundwater reservoirs at the end of the season. The hydrologic balance, illustrated in Figure 1, shows that the increase in the Santa Clara Valley Basin was 20,000 acre-feet, the increase in the Coyote Basin was 4,000 acre-feet,

the increase in the Llagas Basin was 7,000 acre-feet, (these compare favorably to the previously obtained surpluses of 23,000; 2,000 and 7,000 acre-feet, respectively).

The discrepancy observed between the storage changes obtained as a net balance of hydrologic components and that obtained as a product of change in water levels and storage capacity is the result of uncertainties involved in the estimation of subsurface inflows, consumptive use and the storage coefficient of aquifers. However, the results are well within the accuracy acceptable for this kind of computation.


the hydrologic cycle
rain clouds
cloud formation
precipitation
EVAPORATION
EVAPO-TRANSPIRATION
EVAPORATION
EVAPORATION
TRANSPIRATION
EVAPORATION
import
surface runoff
soil percolation
sewage
subsurface
ground water
ocean


TOTAL ALL BASINS
1000'S OF ACRE FEET
0
200
400
600
710
SUPPLY
UTILIZATION
PRECIPITATION 291
STREAM INFLOW 219
SUBSURFACE INFLOW 43
S BA IMPORT 104
HETCH HETCHY IMPORT 53
CONSUMPTIVE USE 397
STREAM OUTFLOW 120
SEWAGE EXPORT 146
SURPLUS 31
SUBSURFACE OUTFLOW 16
679

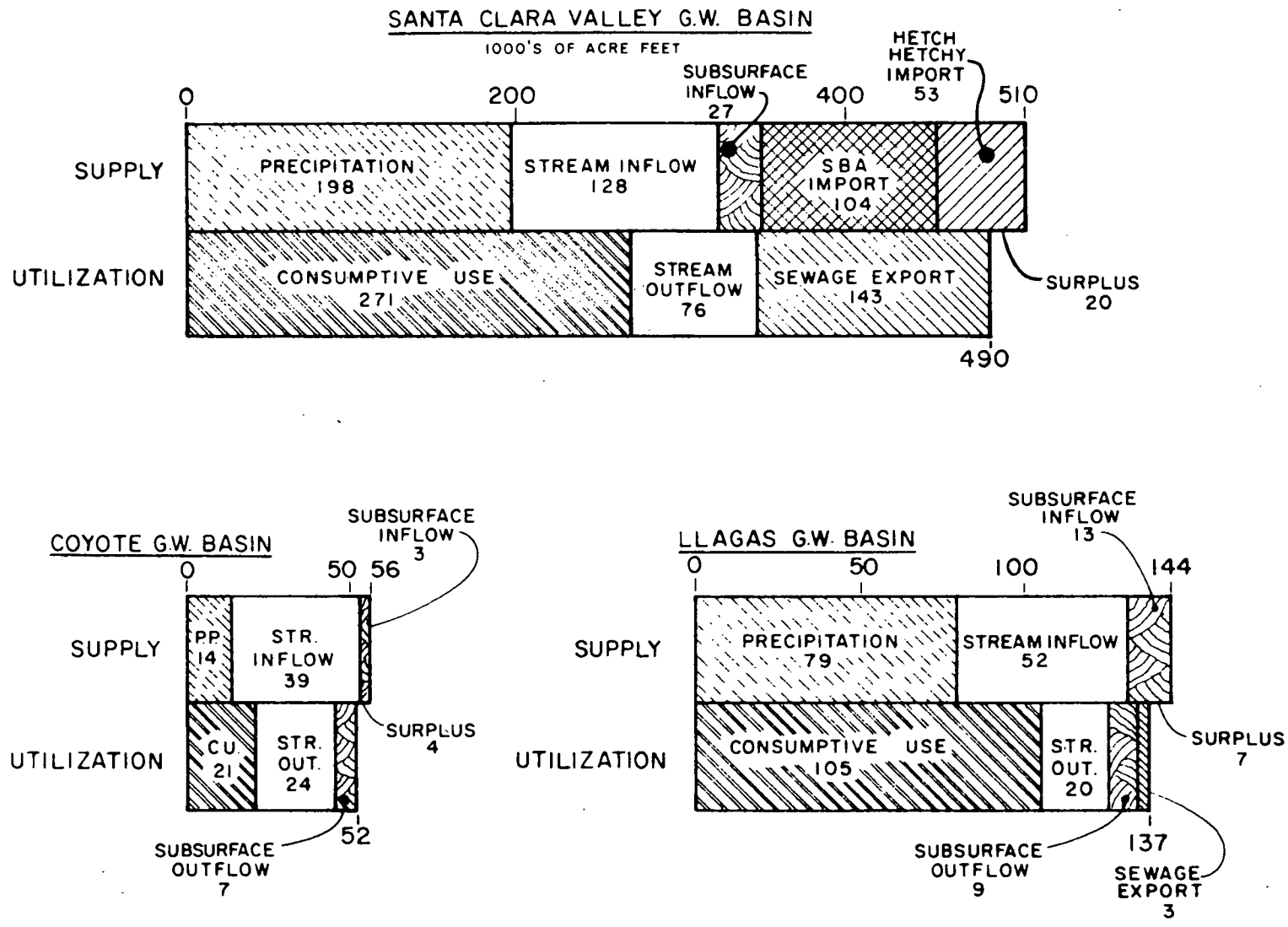


FIGURE 1. HYDROLOGIC BALANCE OF GROUNDWATER 1974-75
(VALUES IN 1000'S ACRE FEET)

GROUNDWATER LEVELS

A groundwater contour map, showing lines of equal elevation of water levels in wells as of September 1, 1975 (traditionally the seasonal low), is shown on Plate 2. Plate 3 shows lines of equal change in elevation of water in wells between June 1, 1974 and June 1, 1975. Plate 4 shows lines of equal depth to water as of September 1, 1975. These groundwater contours are based on information from more than 200 wells.

The monthly fluctuation of water levels from 1970 to 1975 in the Santa Clara Valley, Coyote, and Llagas Basins are presented in Figure 2. These levels represent the weighted average of depths to water in approximately 35 representative wells in both the confined and unconfined zones which are monitored at the beginning of each month. Only the large Santa Clara Valley Basin registered an increase in water levels for 1975 continuing the trend of the previous years. The average water level rose 12 feet over 1974 levels, while water levels in the Coyote and Llagas Basins dropped an average of 3 and 4 feet, respectively. The rise or fall is measured at the low points from year to year which occurs at the end of the pumping season. This year because of the late season pumping both the Coyote and Llagas Basins showed net declines in groundwater levels between Septemter 1974 and September 1975, even though net increases in storage were registered from June '74 to June '75.

In Figures 3 and 4, the historical depths to water are shown, in conjunction with rainfall and population, for the Santa Clara Valley and Llagas Groundwater Basins.

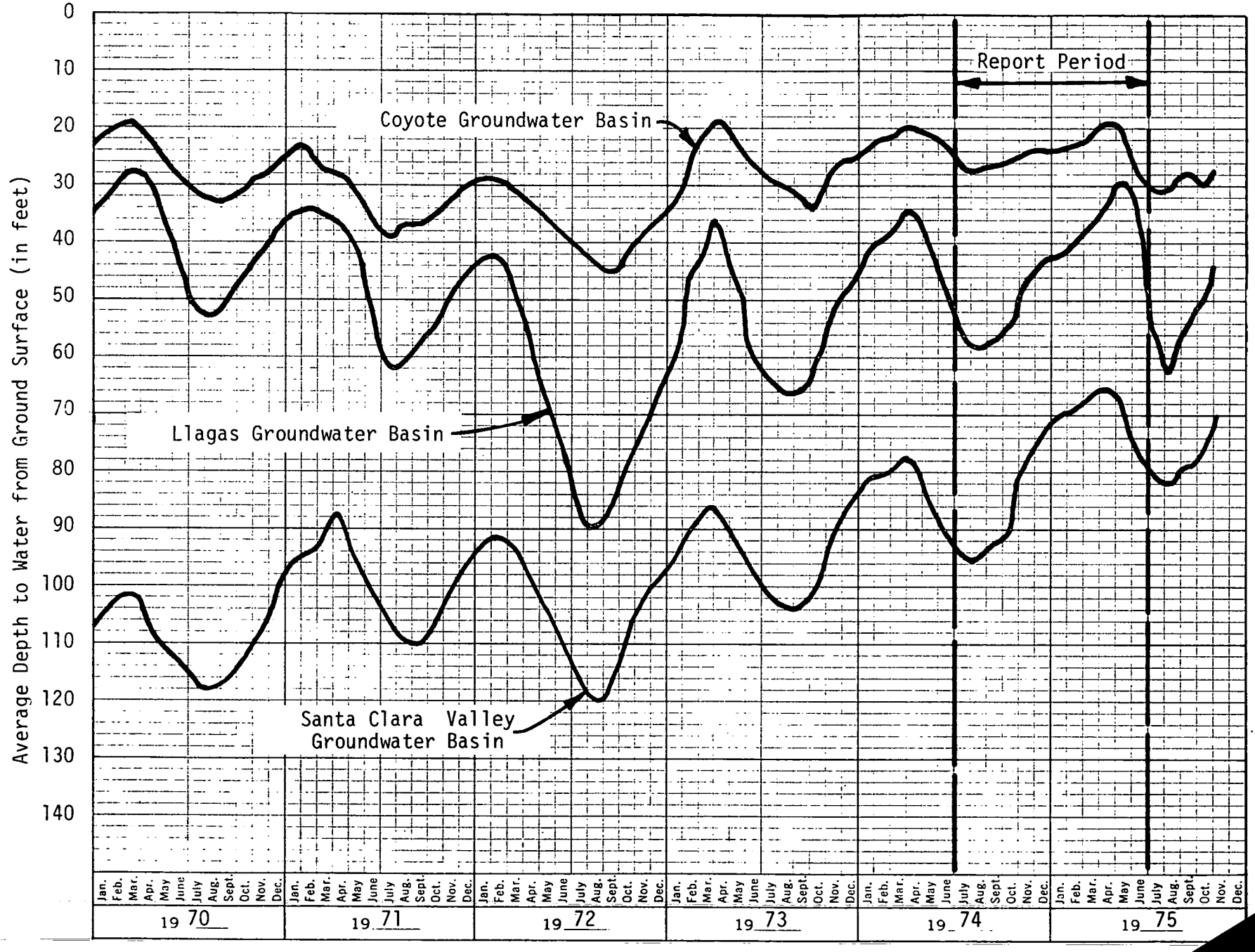


Figure 2. Fluctuations of Average Water Level

Fig. 2

The dependence of water levels on seasonal rainfall is best illustrated in the Llagas Groundwater Basin. This basin is much smaller and shallower than the Santa Clara Valley Groundwater Basin and has a lower storage capability per unit volume. Water levels are, therefore, more responsive to the amount of rainfall in the Llagas Basin.

The north valley basin is less susceptible to large rapid seasonal fluctuations in water levels because of its capacity and because additional sources of supply for the North County make it possible to more effectively manage water releases and distribution. It is possible to carry over from year to year quantities of water stored in the larger reservoirs to be used for groundwater recharge, and to use water imported from the South Bay Aqueduct for recharge when local supplies are low.

The District is continuing its program of recharge of the Santa Clara Valley Groundwater Basin with local and imported water. More than 100,000 acre-feet are recharged through District facilities annually.

FIGURE 3

SANTA CLARA VALLEY BASIN

LAND SUBSIDENCE–

Elevation of U.S. Coast and Geodetic Survey Benchmark P7 in San Jose

POPULATION—

Total Population of Santa Clara County

DEPTH TO WATER –

Average Depth to Water in Feet, in Wells in Santa Clara Valley Groundwater Basin at End of Irrigation Season

RAINFALL—

Total Seasonal Rainfall at U.S. Weather Bureau Station in San Jose

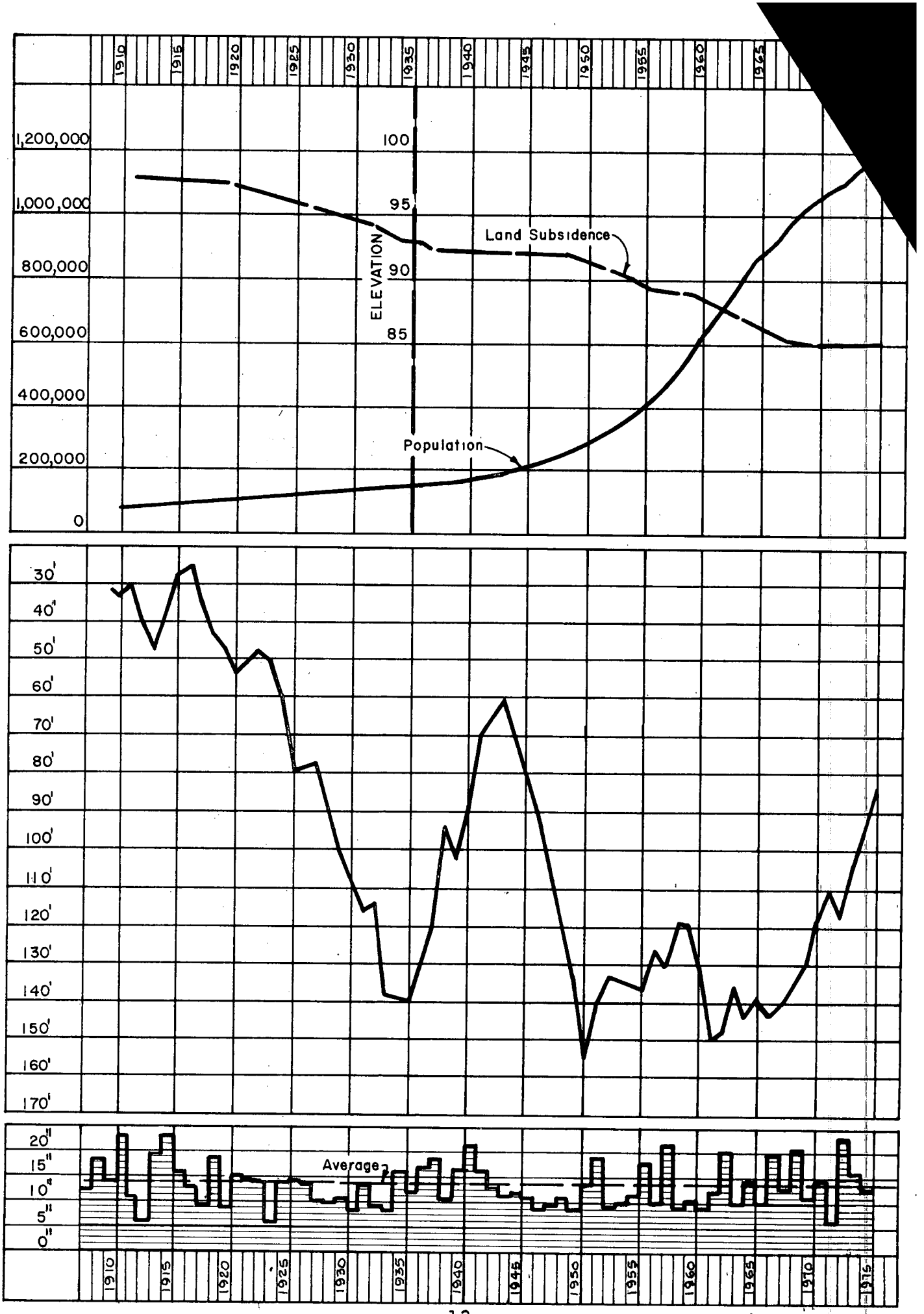

1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
100
95
90
85
ELEVATION
Land Subsidence
Population
30'
40'
50'
60'
70'
80'
90'
100'
110'
120'
130'
140'
150'
160'
170'
20"
15"
10"
5"
0"
Average
1970
1975

Figure 3

FIGURE 4

LLAGAS BASIN

POPULATION—
Combined Populations of the Cities of Morgan Hill and Gilroy

DEPTH TO WATER—
Average Depth to Water in Feet in Wells in Llagas Groundwater Basin at End of Irrigation Season

RAINFALL—
Total Seasonal Rainfall at U.S. Weather Bureau Station in Gilroy

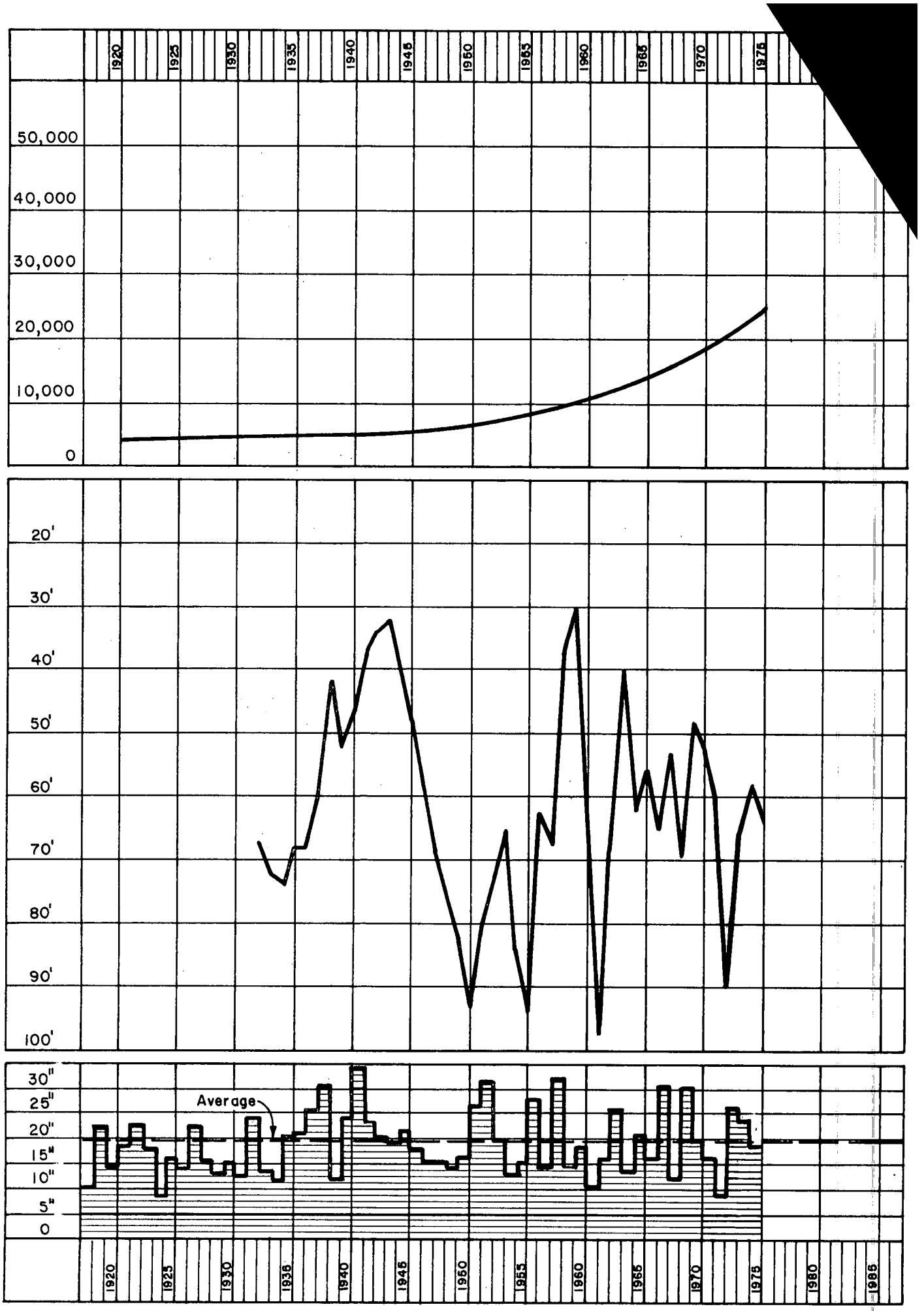

1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
50,000
40,000
30,000
20,000
10,000
0
20'
30'
40'
50'
60'
70'
80'
90'
100'
30"
25"
20"
15"
10"
5"
0
Average
1980
1985

Figure 4

FLOWING WELLS

Flowing artesian wells once numerous in the Santa Clara Valley reappeared on a limited scale last February after a more than 30-year absence. Five wells in the Baylands are known to have flowed in a steady trickle for several weeks in the spring until normal groundwater pumping drew water levels down. An aquifer which is confined under pressure below a strata of impervious sediments is an artesian aquifer. Water will rise in a well piercing the confining stratum to the level of the static pressure (artesian head). If the pressure is sufficient to raise water above the ground, the well is called a flowing well. Unconfined and confined groundwater conditions are illustrated in Figure 5.

Areas where water was flowing this year are shown in Plate 5. Areas of historically flowing wells are also shown, based on a map produced in 1924 by the U. S. Geological Survey. There is evidence that the flowing artesian belt was even bigger in the past than that shown. At one time there were as many as 2,000 flowing artesian wells in the Santa Clara Valley. Fountain Alley in downtown San Jose received its name from an artesian well which flowed copiously and uncontrolled for several days during the early history of the city. One description of the artesian area in 1895 refers to the railroad alignment which still exists:

> "The artesian belt all lies north of the railroad. If the road had been surveyed with a view of defining the artesian belt, it could not have more closely outlined it. From the limit of the basin in the northwestern edge of the

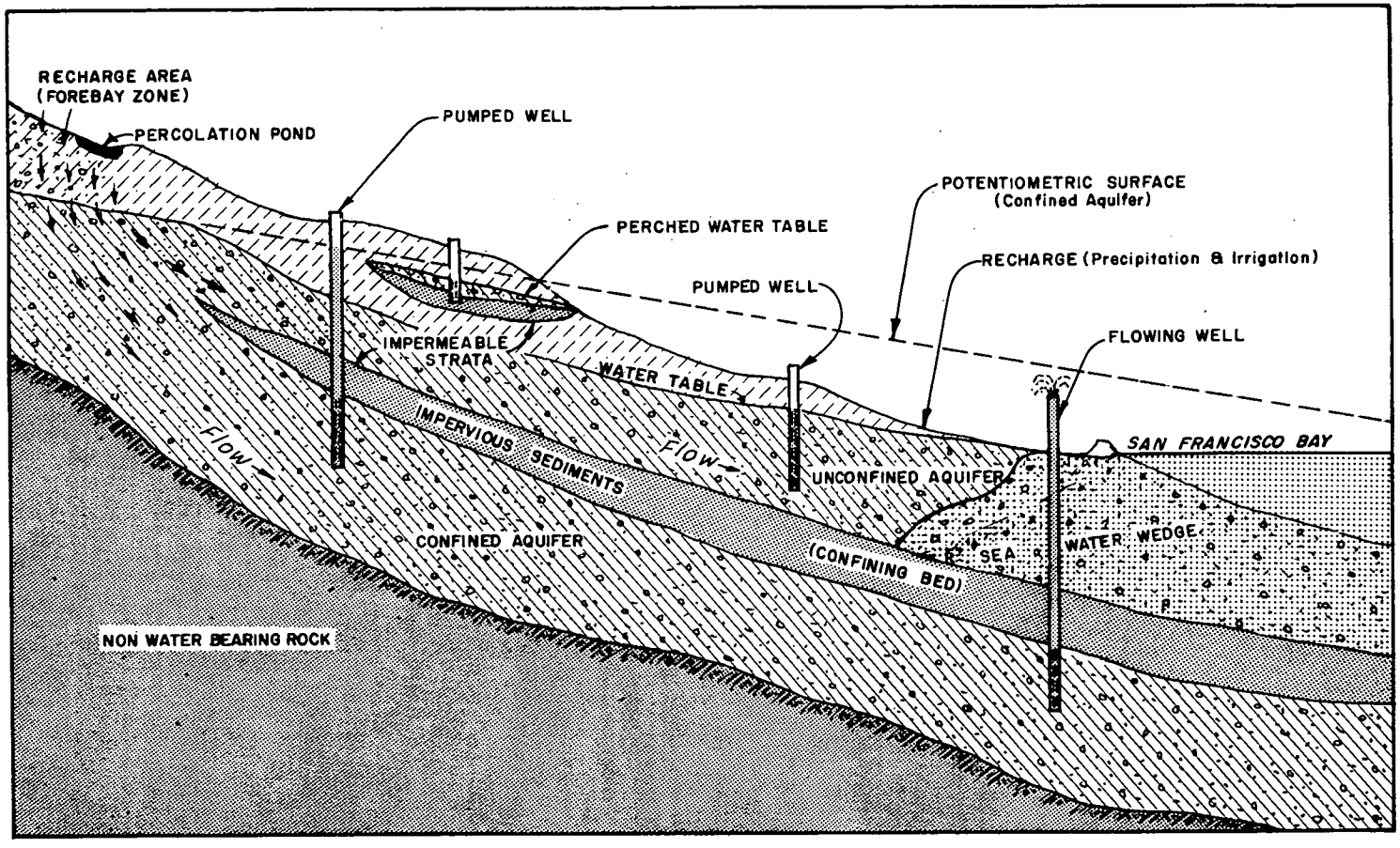


Figure 5 Unconfined and Confined Ground Water

County, near Palo Alto, to San Jose, there are no artesian wells south of the railroad, except two weak ones between Santa Clara and San Jose."

The last time widespread areas of flowing artesian wells occurred was in 1942 following a seven year rise of groundwater levels. Many wells flowed that year including one under the First National Bank in downtown San Jose.

The California Water Code cautions that artesian flows from wells are not to be wasted nor are the artesian pressures to be dissipated needlessly. Artesian flows from wells when not in use are to be controlled by installing a valve.

The well hydrograph in Figure 6 illustrates the typical annual fluctuation cycle and long-term trend of water levels in the Baylands. The figure shows both the long-term decline in water levels prior to 1964 and the rise in water levels after 1964 which has led to the flowing wells.

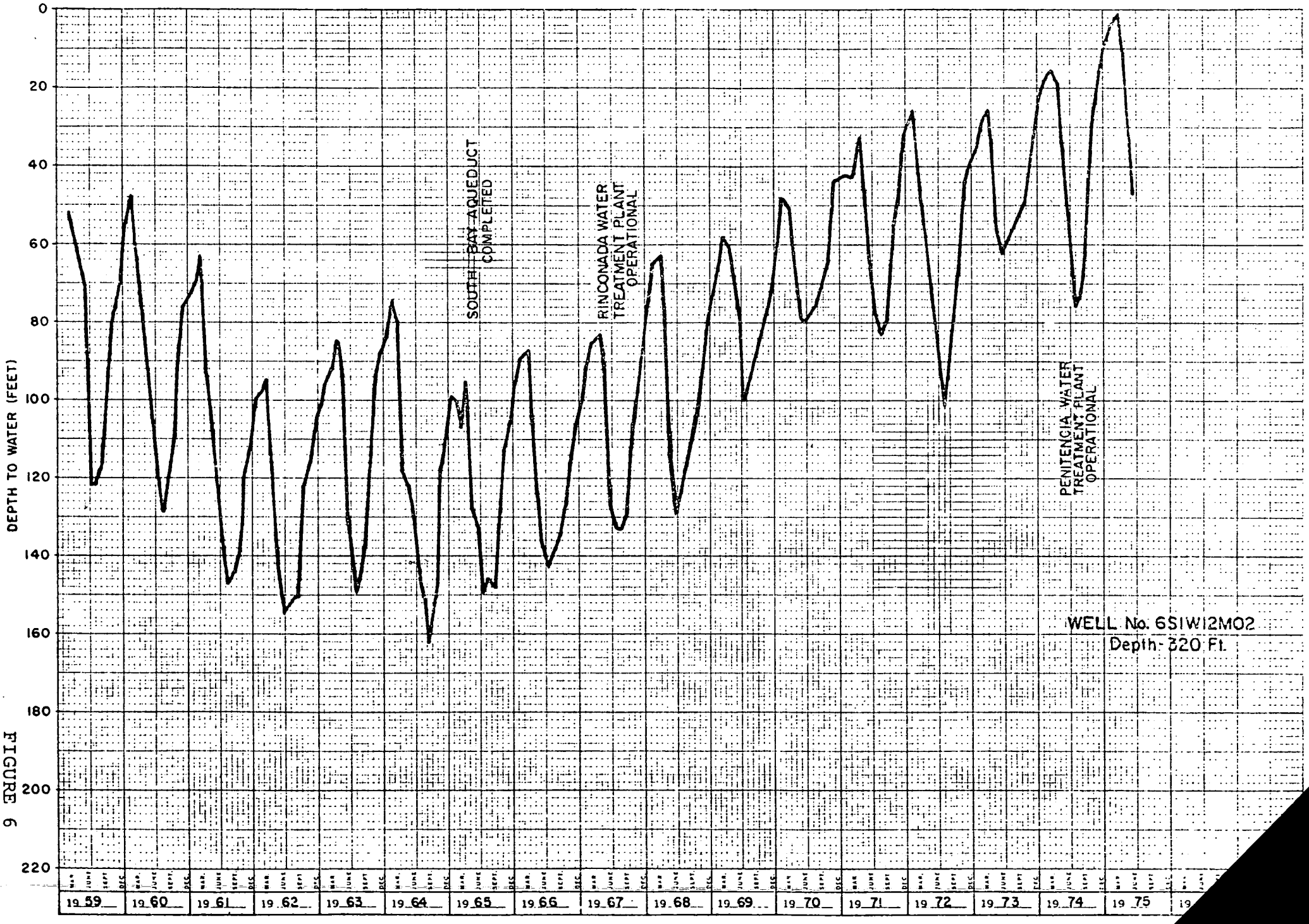


FIGURE 6

TYPICAL HYDROGRAPH FOR WELL IN CONFINED ZONE IN NORTH SANTA CLARA VALLEY (BAYLANDS)

LAND SURFACE SUBSIDENCE

Subsidence of the land surface occurs when intensive groundwater pumping results in lowered artesian pressures in areas of groundwater confinement. This increases the effective overburden load on the clay materials within the confined aquifers causing them to compact, with consequential sinking of the land surface. This relationship between artesian head decline and land subsidence is graphically represented in Figure 3 which illustrates the historical occurrence of subsidence and the corresponding average depths to water.

Subsidence has cost Santa Clara County residents millions of dollars because of its direct effect on the design of and damage to flood control channels, levees, wells, sanitary sewer lines and other underground utilities.

Subsidence in the Santa Clara Valley is a condition carefully watched by the District, who annually makes a survey of ground surface elevations across the Valley floor along the southern end of San Francisco Bay to check for subsidence. The survey for 1975 showed no change in elevation of the Valley floor from that in 1974. Land surface subsidence has not occurred since 1969 because groundwater levels have risen above and have remained above the critical pressure elevation.

The District has been working toward the goal of obtaining water supplies adequate to stop the overdraft of groundwater and to raise the artesian head. As a result of increased imported water supplies, average rainfall, increased artificial recharge,

and decreased pumping, the recovery of groundwater levels since 1966 has been dramatic. Continued halting of subsidence is directly dependent on maintaining groundwater levels above those prevailing in 1969.

IMPORTED WATER

The primary source of imported water for Santa Clara County is the South Bay Aqueduct. During the 1974-75 water year, 104,052 acre-feet of water was delivered into Santa Clara County through the South Bay Aqueduct. Of this total, 51,900 acre-feet was treated at the Rinconada Water Treatment Plant and 15,500 acre-feet was treated at the new Penitencia Water Treatment Plant for delivery to consumers through retail water agencies. In addition, 605 acre-feet of raw water was delivered directly from District pipelines for use by individual contractors. The remaining 36,048 acre-feet was percolated into the underground through the District's recharge facilities.

The total South Bay Aqueduct import for the calendar year 1975 was 106,470 acre-feet. For the calendar year 1976, the District is obligated by contract to purchase its entitlement of 88,000 acre-feet from the State. In addition, 12,000 acre-feet of surplus water has been requested for a total expected delivery of 100,000 acre-feet.

A second source of imported water comes from the Sierras via the San Francisco Water Department's Hetch Hetchy Aqueduct. The Hetch Hetchy system has been supplying water to Santa Clara County since 1952. During the water year 1974-75, this system delivered 53,425 acre-feet directly to the water supply systems of the cities of Milpitas, San Jose, Sunnyvale, Santa Clara, Mountain View and Palo Alto and to the Purissima Hills County Water District.

Small amounts of this water were also delivered to Stanford University, NASA, Moffett Field, Agnews State Hospital and other local contractors.

The existing and proposed water conveyance, treatment and distribution system for the Santa Clara Valley is shown in Figure 7.

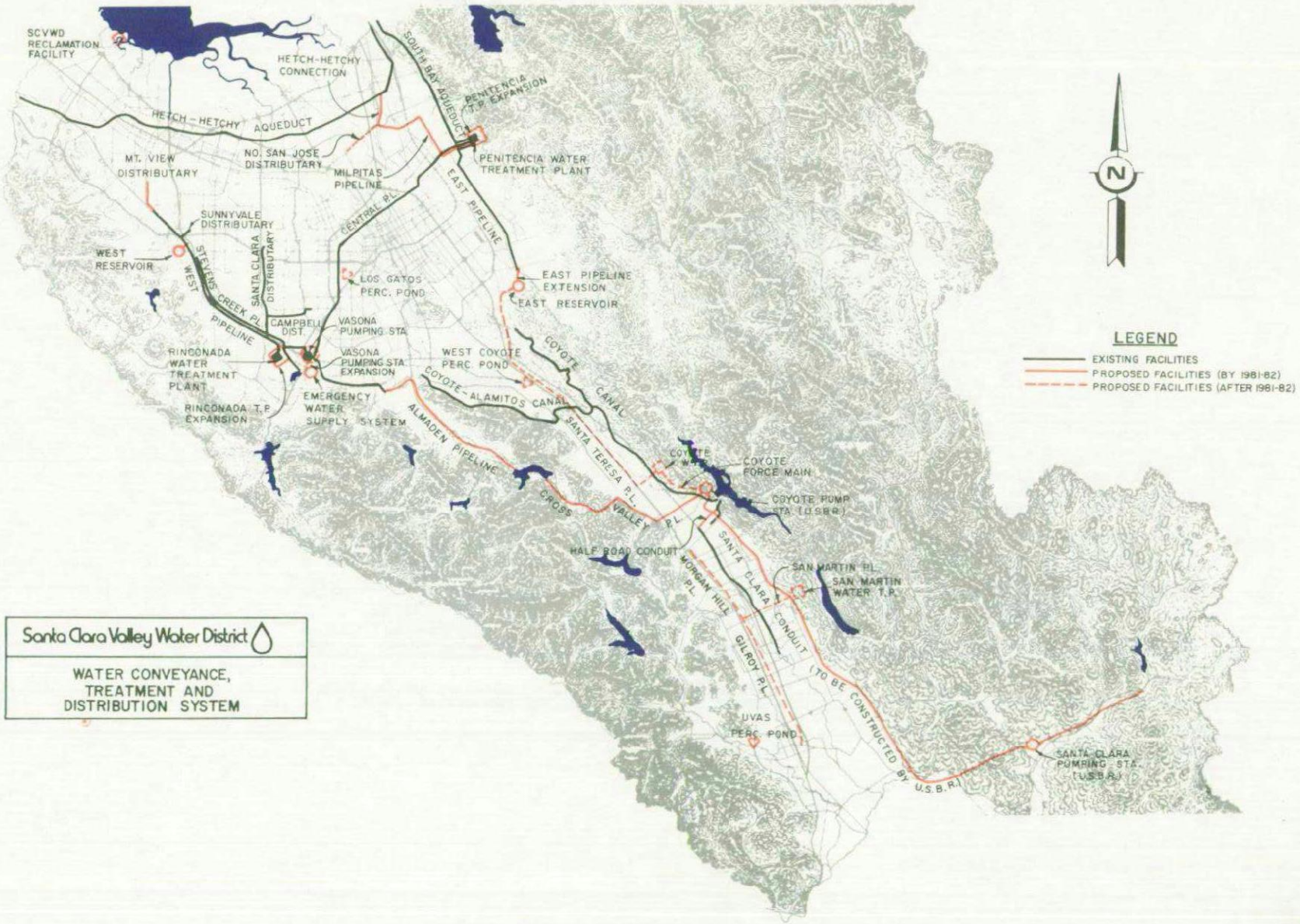

SCVWD RECLAMATION FACILITY
HETCH-HETCHY CONNECTION
HETCH-HETCHY AQUEDUCT
SOUTH BAY AQUEDUCT
PENITENCIA T.P. EXPANSION
PENITENCIA WATER TREATMENT PLANT
MT. VIEW DISTRIBUTARY
NO. SAN JOSE DISTRIBUTARY
MILPITAS PIPELINE
CENTRAL PL.
EAST PIPELINE
SUNNYVALE DISTRIBUTARY
WEST RESERVOIR
STEVENS CREEK PL.
SANTA CLARA DISTRIBUTARY
WEST PIPELINE
LOS GATOS PERC. POND
EAST PIPELINE EXTENSION
EAST RESERVOIR
CAMPBELL DIST.
VASONA PUMPING STA.
VASONA PUMPING STA. EXPANSION
RINCONADA WATER TREATMENT PLANT
RINCONADA T.P. EXPANSION
EMERGENCY WATER SUPPLY SYSTEM
WEST COYOTE PERC. POND
COYOTE CANAL
COYOTE-ALAMITOS CANAL
SANTA TERESA P.L.
ALMADEN PIPELINE
CROSS VALLEY P.L.
COYOTE WATER
COYOTE FORCE MAIN
COYOTE PUMP STA. (U.S.B.R.)
HALF ROAD CONDUIT
MORGAN HILL P.L.
SANTA CLARA CONDUIT (TO BE CONSTRUCTED BY U.S.B.R.)
SAN MARTIN P.L.
SAN MARTIN WATER T.P.
GILROY P.L.
UVAS PERC. POND
SANTA CLARA PUMPING STA. (U.S.B.R.)
N
LEGEND
EXISTING FACILITIES
PROPOSED FACILITIES (BY 1981-82)
PROPOSED FACILITIES (AFTER 1981-82)
Santa Clara Valley Water District
WATER CONVEYANCE, TREATMENT AND DISTRIBUTION SYSTEM

Figure 7

WATER SUPPLY

Rainfall is the source of all locally developed water supplies. The long-term precipitation at San Jose is illustrated in Figure 8 as the accumulated departure from the mean which denotes graphically the wet and dry periods of rainfall. The important feature in Figure 8 is the slope of the curve; particularly whether it is positive or negative. Each point is plotted as a difference from the long-term averages; a wet year showing a positive difference and a dry or below normal rainfall year indicating a negative difference. If each difference is added to that of the previous year, a trend of positive or negative increments becomes apparent. An upward trend would, therefore, indicate a period of years which have received above normal rainfall and a downward trend would be indicative of a drought period.

The accumulated departure from the mean is used to identify long-term wet and dry periods. Despite short-term fluctuations, the long-term periods are evident in Figure 8.

Beginning in 1875, rainfall approximated the long-term average until 1890 when a series of wet years began which generally continued through about 1916. The valley experienced low rainfall for several years following 1920 until 1935. It was during this drought period that valley residents first initiated a comprehensive water conservation program. The completion of the valley's first five water supply reservoirs in 1935 coincided with a short interval of above-average rainfall. This enhanced the water supply picture and enabled groundwater levels, which had

been declining, to recover. There is a remarkable correlation between the depth-to-water in Figure 3 and the accumulated departure from the average rainfall in Figure 8.

Between 1943 and 1962, another series of dry years occurred. Since 1962, the valley has had rainfall slightly above the long-term average.

The demand for water and the amount of water available for supply are both very dependent on seasonal rainfall. In a below normal rainfall year when water supplies are low, the demand for municipal, industrial and agricultural water increases, while in a wet year, water demand drops. Shown on Figure 9 are the water demand projections for the period 1970 to 2020 and the recorded water use through 1975. The projections are based on the assumption of average seasonal rainfall. Estimates of the seasonal groundwater extractions through 1977 for each of the three basins are shown in Table 1. Actual water production in the North County for 1970-75 from <u>all</u> sources of supply is summarized in Table 2.

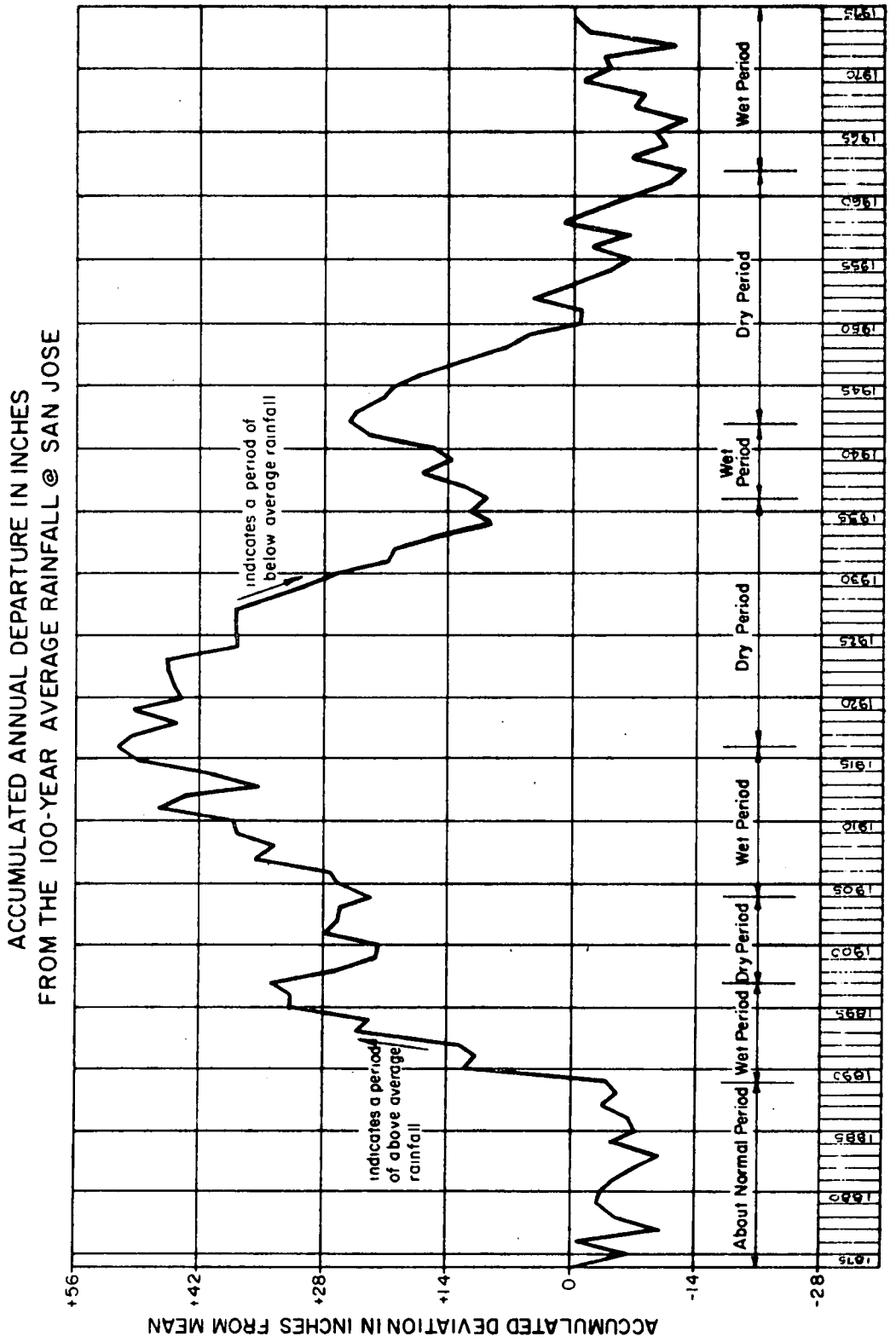

ACCUMULATED ANNUAL DEPARTURE IN INCHES
FROM THE 100-YEAR AVERAGE RAINFALL @ SAN JOSE
ACCUMULATED DEVIATION IN INCHES FROM MEAN
+56
+42
+28
+14
0
-14
-28
1875
1880
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
About Normal Period
Wet Period
Dry Period
Wet Period
Dry Period
Wet Period
Dry Period
Wet Period
Dry Period
Wet Period
indicates a period of above average rainfall
indicates a period of below average rainfall

FIGURE 8

PROJECTED WATER DEMAND AND ACTUAL WATER PRODUCTION

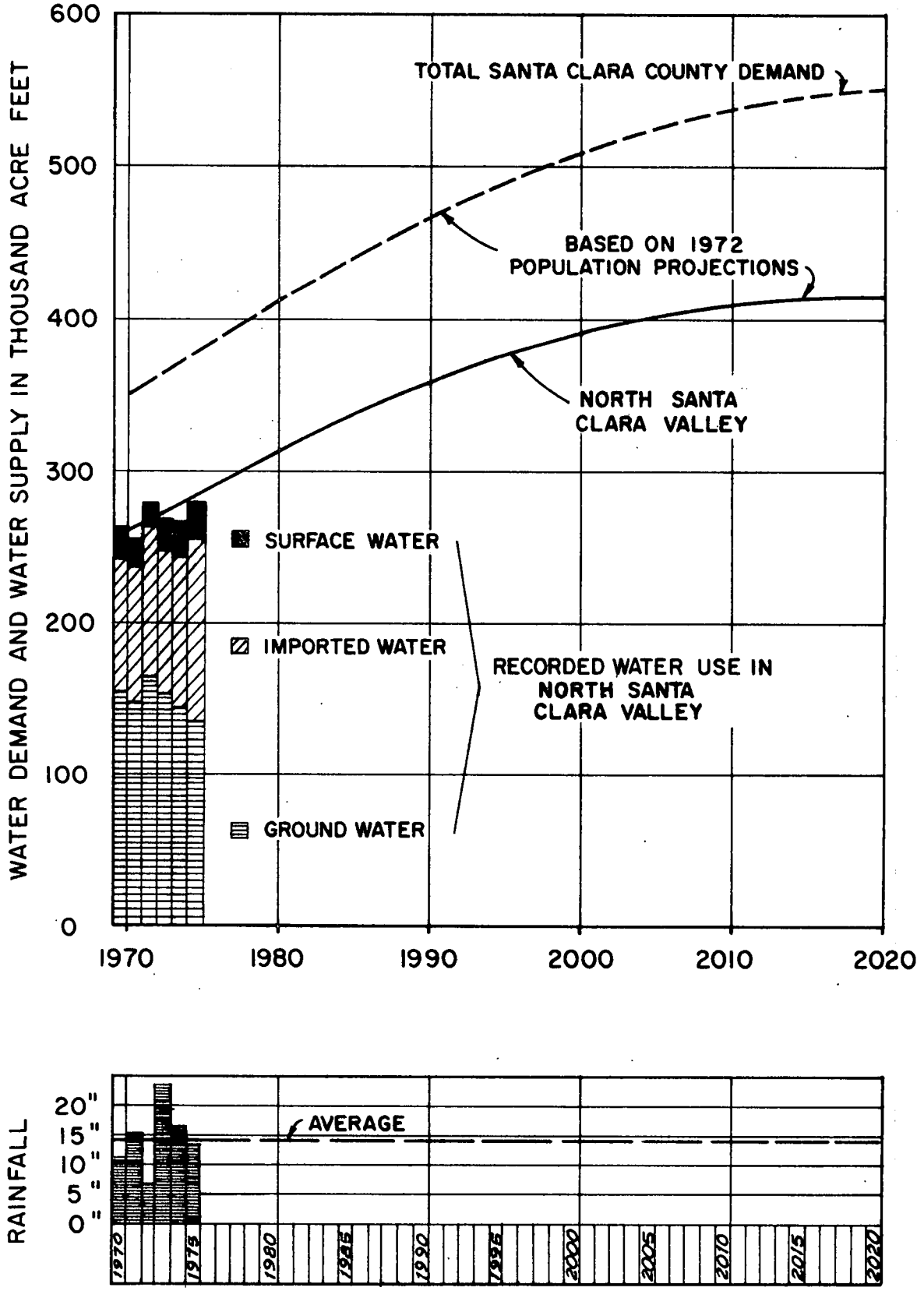


FIGURE 9

TABLE 1

ESTIMATED SEASONAL GROUNDWATER EXTRACTIONS
(VALUES IN ACRE-FEET)
ASSUMING AVERAGE RAINFALL

Water Year and Use	Groundwater Basin			
	Santa Clara Valley	Coyote	Llagas	Total
1974-75				
Agric. Use	16,900*	10,000	62,000	88,900
Urban Use	120,400*	500	10,000	130,900
Total	137,300*	10,500	72,000	219,800
1975-76				
Agric. Use	17,200	11,000	63,800	92,000
Urban Use	122,000	500	10,500	133,000
Total	139,200	11,500	74,300	225,000
1976-77				
Agric. Use	17,200	11,500	65,700	94,400
Urban Use	124,000	500	10,700	135,200
Total	141,200	12,000	76,400	229,600

*These are the recorded extractions.

TABLE 2

WATER USE SUMMARY

Santa Clara Valley Groundwater Basin

(values in acre-feet)

Fiscal Year	Surface Water Ag	Surface Water Non-Ag	Groundwater Ag	Groundwater Non-Ag	SBA Import Contracted Treated	SBA Import Contracted Untreated	Hetch Hetchy	SJWW Diversion	Total
69-70	4900	800	29300	125100	39200	500	48300	15800	263,900
70-71	4400	1100	23700	124300	44000	700	45200	12900	256,300
71-72	4800	1500	24000	142200	48800	800	49900	8800	280,700
72-73	4200	1600	17500	137800	45000	600	48900	14600	270,200
73-74	3000	1800	15900	129000	45500	600	52200	20800	268,700
74-75	3500	1900	16900	120400	67400	600	53400	17500	281,600

WATER QUALITY

Surface waters of the Santa Clara Valley are generally of excellent mineral quality, characterized by relatively low concentrations of dissolved solids, low percent sodium, and, with some exceptions in the Penitencia area, low boron content.

Groundwater pumped from most of the existing wells in the County's basins is of good quality and, in general, meets all requirements for drinking water as set forth in the Standards of the U. S. Public Health Service. Groundwaters from properly constructed and protected wells, including many municipal well fields, are in some places used directly without chlorination.

Graphical representations of some significant water quality parameters at selected wells are shown in Figures 10, 11, and 12. The locations of these wells are shown on Plate 1. Generally, the pumped water may be classified as moderately to extremely hard. Hardness of water is caused principally by compounds of calcium and magnesium.

Certain localized areas have yielded groundwater of poor quality. Groundwater is subject to contamination in areas of intensive land use. The principal surface sources of contamination are septic tanks, surface ponding of contaminants and pollutants, and questionable waste disposal practices. From subsurface sources, the threat of degradation comes from salt-water intrusion from San Francisco Bay (Plate 6) or from mineralized connate waters found at depth.

Another factor which may contribute to the degradation of the groundwater is the method of well construction. Properly

constructed wells eliminate the possibility of the well functioning as a channel for the movement of water between contaminated (or degraded) and uncontaminated aquifers and also prevent contamination from surface sources. Improper methods of well construction and destruction, if allowed, could contribute to the deterioration of freshwater aquifers. Once an aquifer becomes contaminated or degraded, its restoration is extremely difficult and, in some cases, not economically feasible. Such a situation has already occurred in adjacent counties near San Francisco Bay. In order to help prevent this from happening in Santa Clara County, the District has adopted well construction and destruction standards (SCVWD Ordinance No. 75-6). The purpose of these standards is to protect and preserve the groundwater supply in aquifers for future uses.

To aid in the management and protection of the quality of all the waters in the valley, the District has initiated a two-year joint water quality program with the Department of Water Resources and the U. S. Geological Survey. The objective of the program is to develop a comprehensive plan for monitoring the quality of waters in the underground basins, streams, and surface reservoirs.

In a related study the Department of Water Resources is cooperating with the District in a limnological investigation of Anderson Reservoir. Limnology is the study of physical, chemical, and biological conditions of a freshwater body and its tributary streams and watershed. Upon completion of the Anderson Reservoir investigation, other reservoirs may be studied. The product of

these investigations will be a collection of adequate baseline water quality data for each reservoir. This information is a valuable tool for identifying sources of contamination and setting reservoir operation criteria. Indications of trends brought out through regular monitoring will make it possible to predict the impact of projected land use changes.

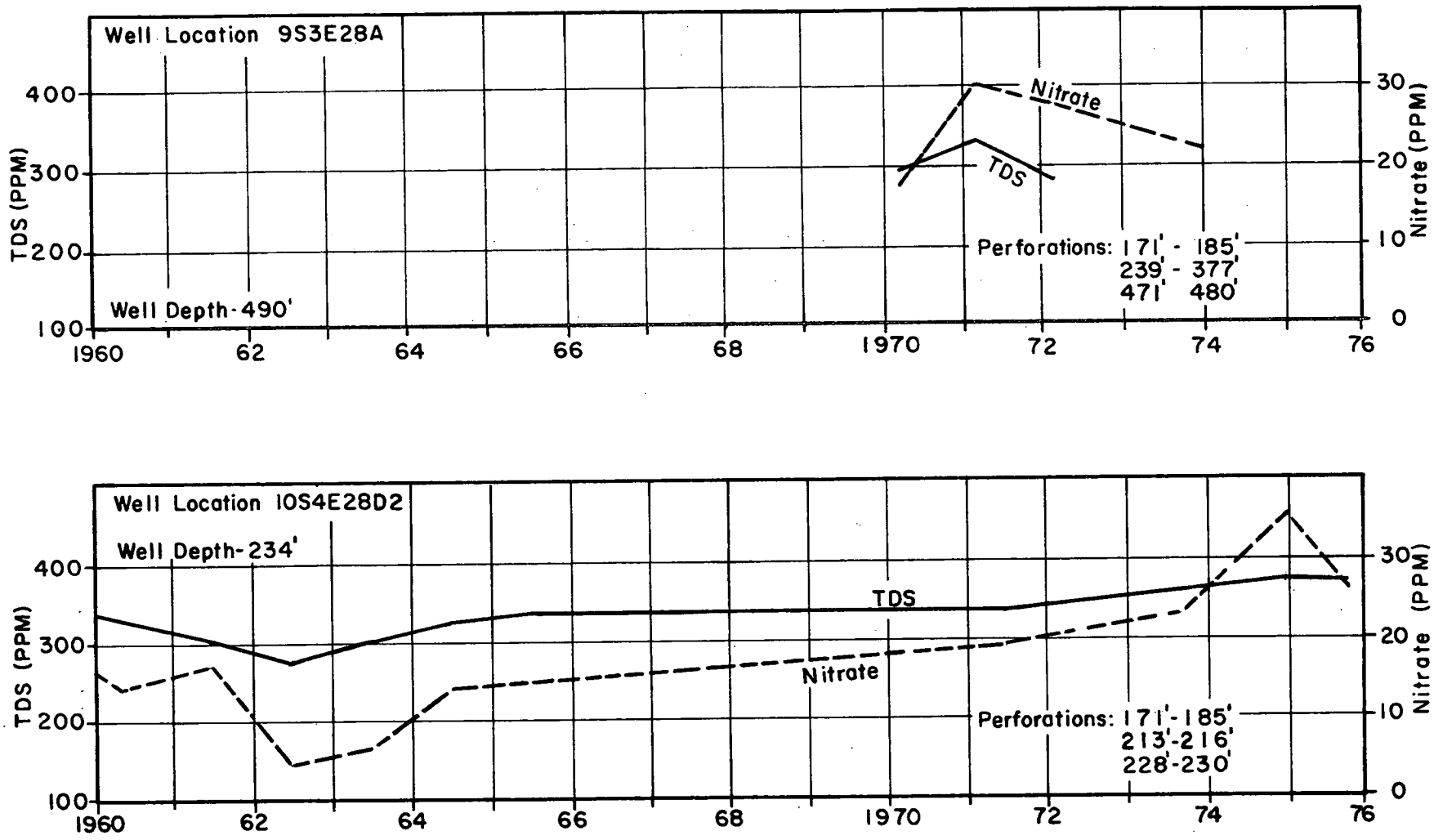


Figure 10. Temporal Variation of Nitrates and TDS-Llagas Basin

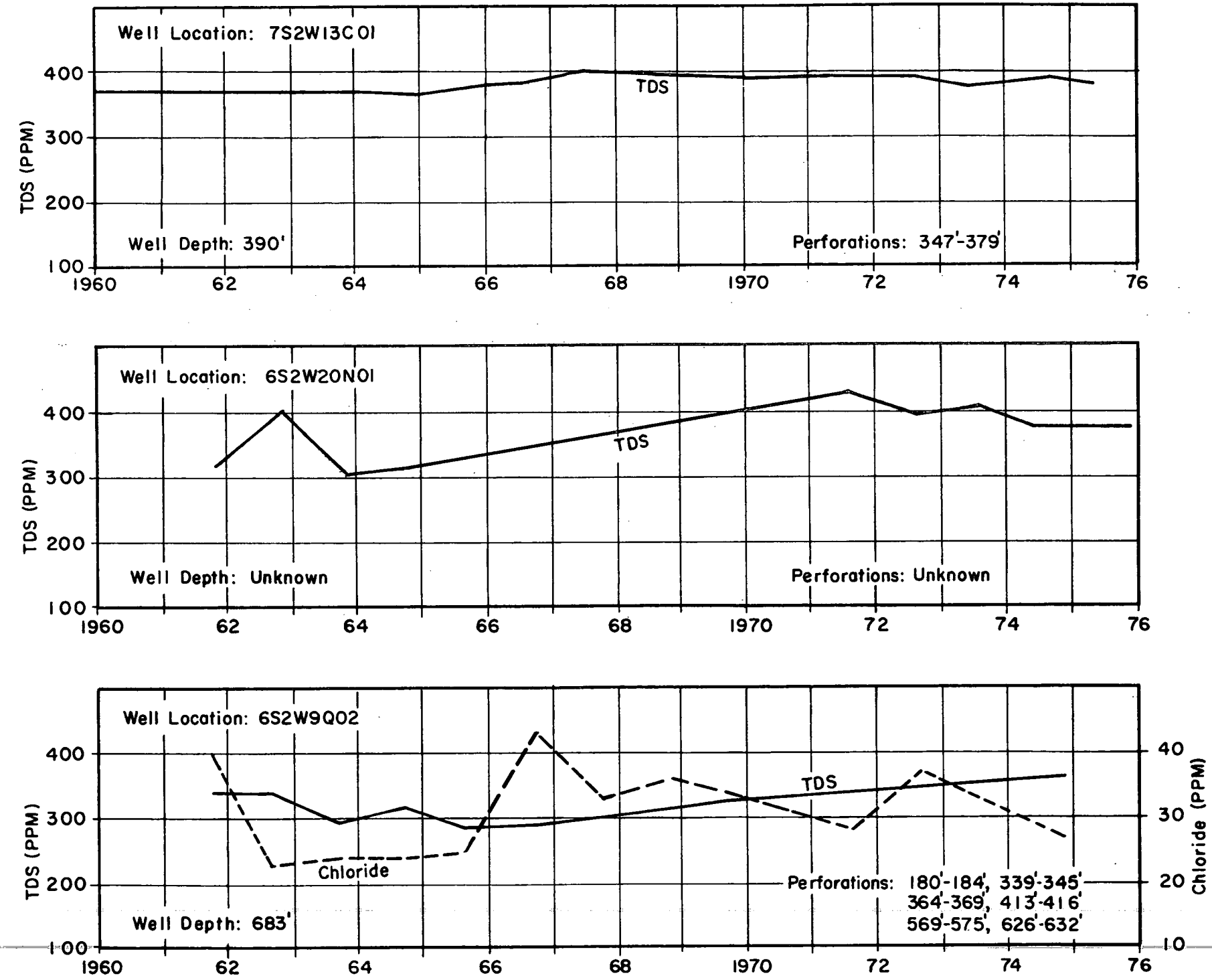


Figure 11 Temporal Variation of TDS and Chloride-
Santa Clara Valley Groundwater Basin

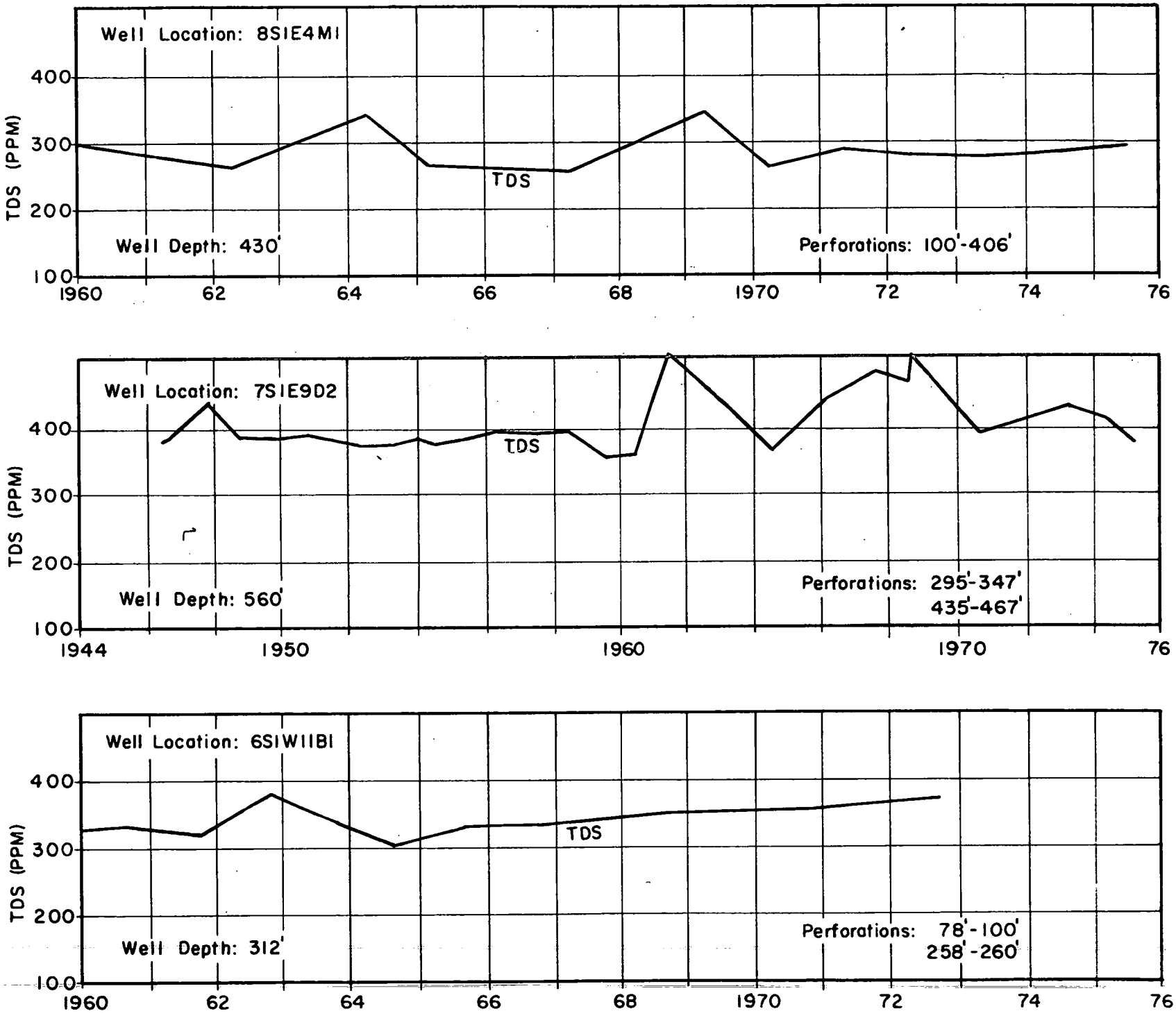


Figure 12. Temporal Variation of TDS-Santa Clara Valley Groundwater Basin

SALTWATER CONTAMINATION

Along the margins of South San Francisco Bay are shallow aquifers (less than 150 feet deep), which contain saltwater contaminated water. These aquifers and the poor quality water they contain are important to water management within the County because they overlie the deep artesian aquifers which are a major source of water supply to the County. Therefore, the delineation of areas where the shallow groundwater is of inferior quality is an aid in assessing potential hazards to the deep aquifers and in planning for their protection against contamination.

The District contracted with Arthur J. Inerfield and Associates, Consulting Engineers, to study and report on the extent of the shallow aquifer contamination. Their report titled "Review of Shallow Groundwater Zone Salinity Monitoring Program" was completed in February 1976 and is abstracted in the following paragraphs.

The chloride content of local uncontaminated, shallow groundwater normally ranges between about 40 and 60 mg/l. When levels of mineralization are found to be substantially greater, it can be reasonably assumed that some special contaminating influence is involved. A chloride index level of 100 mg/l was adopted to define areas which have been subjected to noticeable alteration of quality. Plate 6 delineates the gross areas within which maximum shallow zone chloride concentrations of 100, 500, 1000 and 2000 mg/l have been found.

The distribution pattern of excessive chloride occurrence shows a bay-related origin for shallow zone contamination.

Several possible contamination processes are suggested by these patterns. Although the available data does not allow a conclusive analysis there is a reasonable basis for preliminary and tentative concepts pending further investigation. These are discussed below.

Given the ready availability of saline waters, intrusion can be induced by the severe lowering of the shallow aquifer piezometric level by heavy well pumping as has occurred in the Niles Cone area in Fremont. Historical records show that the shallow aquifers in Santa Clara County have never been subjected to comparable heavy pumping development and overdraft. Consequently, there is no evidence that there ever was piezometric lowering sufficient to create and sustain landward flow gradients from the Bay. The mechanism of saline intrusion of shallow aquifers in the classical sense and, as found in the Fremont area, does not appear to account for all of the shallow zone contamination in Santa Clara County. However, many fringe areas immediately adjacent to the bay water have definitely been intruded in this manner.

The incursion of tidal waters inland along watercourses appear to affect near surface semi-perched aquifers in adjacent areas. Inland incursion of tidal waters has increased markedly along most watercourses. Land subsidence has been chiefly responsible for this by lowering channel grades.

The stream most affected by channel lowering and increased tidal incursion is Guadalupe River, due to its location in areas of greatest subsidence and to channel improvements which have lowered the channel bottom. Whatever the actual extent of channel lowering, it has obviously been substantial. This has allowed tidal effects to reach several miles farther inland along

Guadalupe River than was previously possible. This appears to be reflected by the southerly prolongation of shallow groundwater contamination delineated in Plate 6. No other stream has suffered the amount of grade lowering and subsequent tidal incursion as has the Guadalupe River.

In the vicinity of the Palo Alto baylands the saltwater contamination has resulted from the classical intrusion from the bay waters. To reduce this intrusion and protect the aquifer the District has undertaken the design of a system which will inject water into the shallow aquifers through wells. The injected water will set up a hydraulic barrier against intrusion.

The water for injection will be furnished by a 3 MGD Water Reclamation Plant which will provide advanced treatment of effluent from the Palo Alto Regional Water Quality Control Plant.

A key part of the implementation of the reclaimed water well injection program will be the instituting of a comprehensive monitoring program with special emphasis upon public health aspects. The aquifer into which reclaimed water is to be injected is not currently used for a public water supply. Thus, the project has the unique possibilities of helping to prevent contamination of good quality groundwater while at the same time providing the basis for research into the possible utilization of reclaimed water to augment other sources of supply in order to satisfy future water needs.

GLOSSARY

Aquifer - A geologic formation that stores, transmits, and yields significant quantities of water to wells and springs.

Artesian Well - A well tapping a confined or artesian aquifer in which the static water level stands above the top of the aquifer. If the water level rises above ground level, the well would be a flowing artesian well.

Consumptive Use - Water consumed by vegetative growth in transpiration and building of plant tissue, and water evaporated from adjacent soil, from water surfaces, and from foliage. Also, water similarly consumed and evaporated by urban and nonvegetative types of land use.

Contamination - Any introduction into water of microorganisms, chemicals, wastes or wastewater in a concentration that makes the water unfit for its intended use.

Dry Period - An historic period of years when water supply is much below normal. An example was 1929-34 when the water in northern California streams averaged only about 38 percent of normal. It has been used as the reference drought situation in much water resource planning.

Hydrology - The origin, distribution, and circulation of waters of the earth - precipitation, streamflow, infiltration, groundwater storage, and evaporation.

Hydrology, Groundwater - The branch of hydrology that deals with groundwater - occurrence, movement, replenishment, and depletion.

Infiltration - The movement of water through the soil surfaces and into the soil.

Injection Well - Well used for introducing water into an aquifer. Technique used to stop seawater intrusion, replenish an aquifer, or dispose of cooling water.

Overdraft - The condition in a groundwater basin where the amount of water withdrawn by pumping exceeds the amount of water replenishing the basin over a period of time.

Percolation - The slow movement of water through the soil or alluvium to and beneath the groundwater table.

Total Dissolved Solids (TDS) - The quantity of minerals (salts) in solution in water, usually expressed in milligrams per liter or parts per million.

Water Table - The surface where groundwater is encountered in a well in an unconfined aquifer.

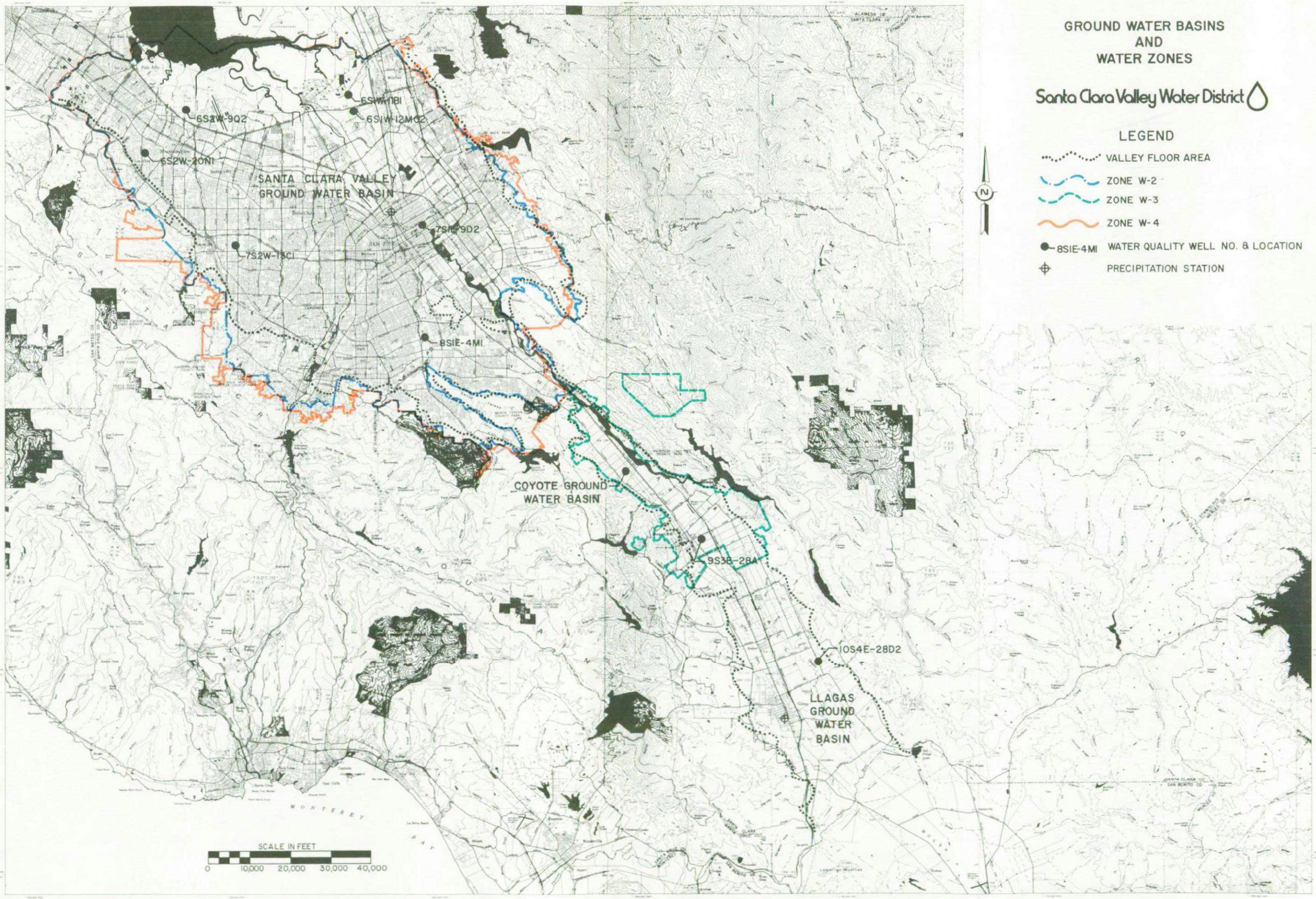

GROUND WATER BASINS
AND
WATER ZONES
Santa Clara Valley Water District
LEGEND
VALLEY FLOOR AREA
ZONE W-2
ZONE W-3
ZONE W-4
8SIE-4MI WATER QUALITY WELL NO. & LOCATION
PRECIPITATION STATION
N
6S2W-9Q2
6S1W-11B1
6S1W-12M02
6S2W-20N1
SANTA CLARA VALLEY
GROUND WATER BASIN
7S1E-9D2
7S2W-13C1
8S1E-4M1
COYOTE GROUND
WATER BASIN
9S3E-28A1
10S4E-28D2
LLAGAS
GROUND
WATER
BASIN
MONTEREY
BAY
SCALE IN FEET
0
10,000
20,000
30,000
40,000

PLATE 1

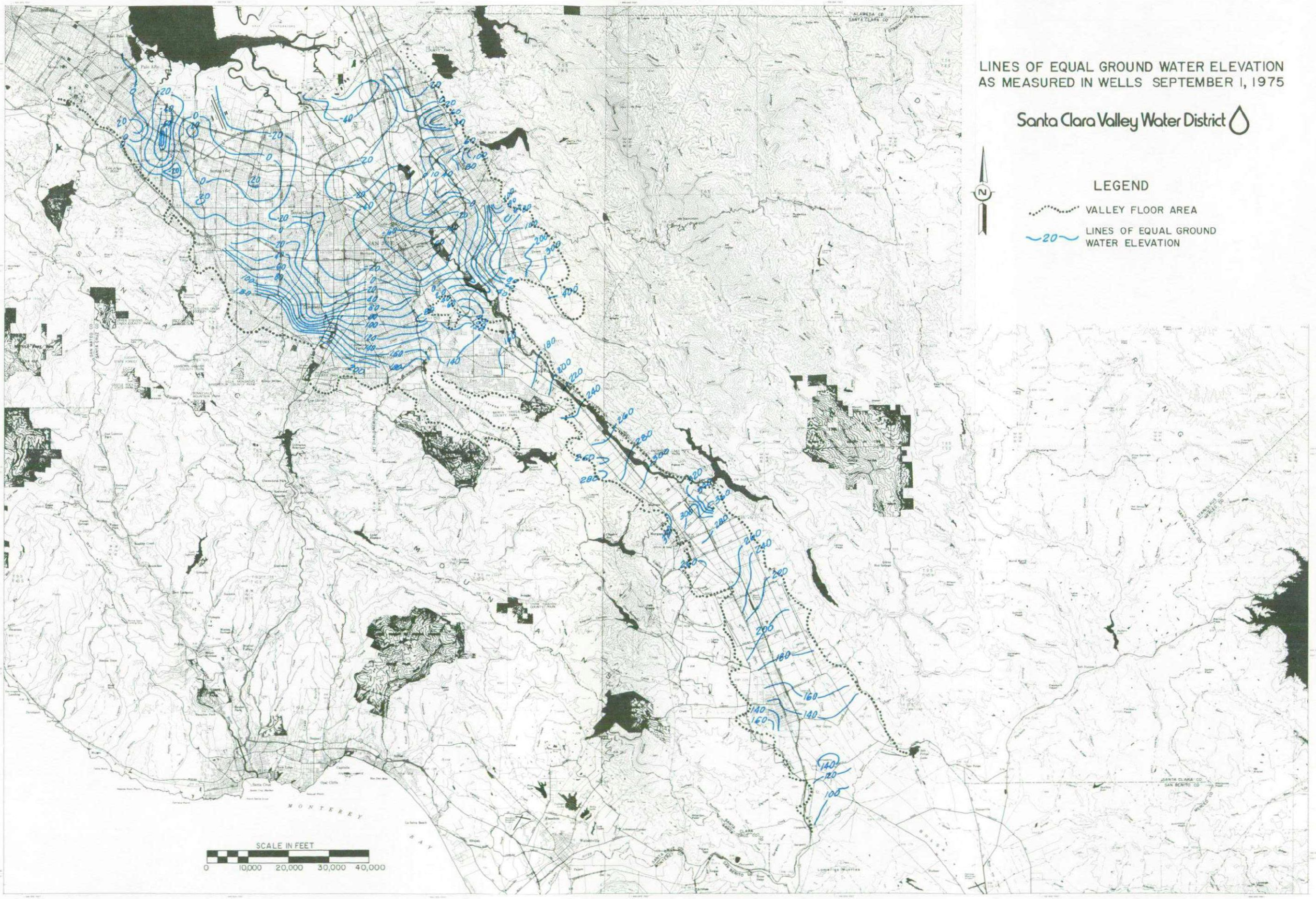

LINES OF EQUAL GROUND WATER ELEVATION
AS MEASURED IN WELLS SEPTEMBER 1, 1975
Santa Clara Valley Water District
LEGEND
VALLEY FLOOR AREA
LINES OF EQUAL GROUND WATER ELEVATION
SCALE IN FEET
0 10,000 20,000 30,000 40,000
MONTEREY BAY

PLATE 2

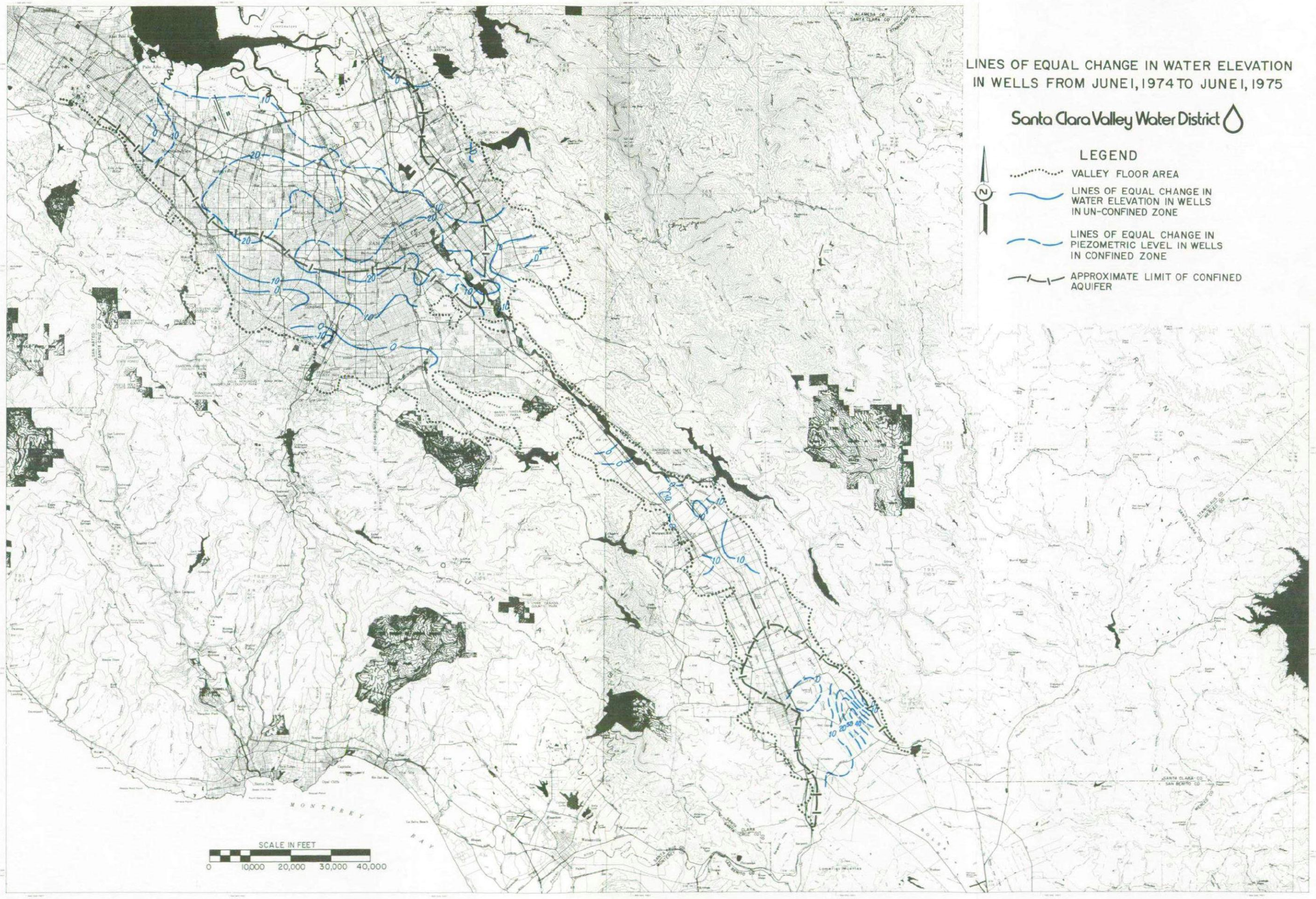

LINES OF EQUAL CHANGE IN WATER ELEVATION
IN WELLS FROM JUNE 1, 1974 TO JUNE 1, 1975
Santa Clara Valley Water District
LEGEND
VALLEY FLOOR AREA
LINES OF EQUAL CHANGE IN WATER ELEVATION IN WELLS IN UN-CONFINED ZONE
LINES OF EQUAL CHANGE IN PIEZOMETRIC LEVEL IN WELLS IN CONFINED ZONE
APPROXIMATE LIMIT OF CONFINED AQUIFER
SCALE IN FEET
0 10,000 20,000 30,000 40,000
MONTEREY BAY

PLATE 3

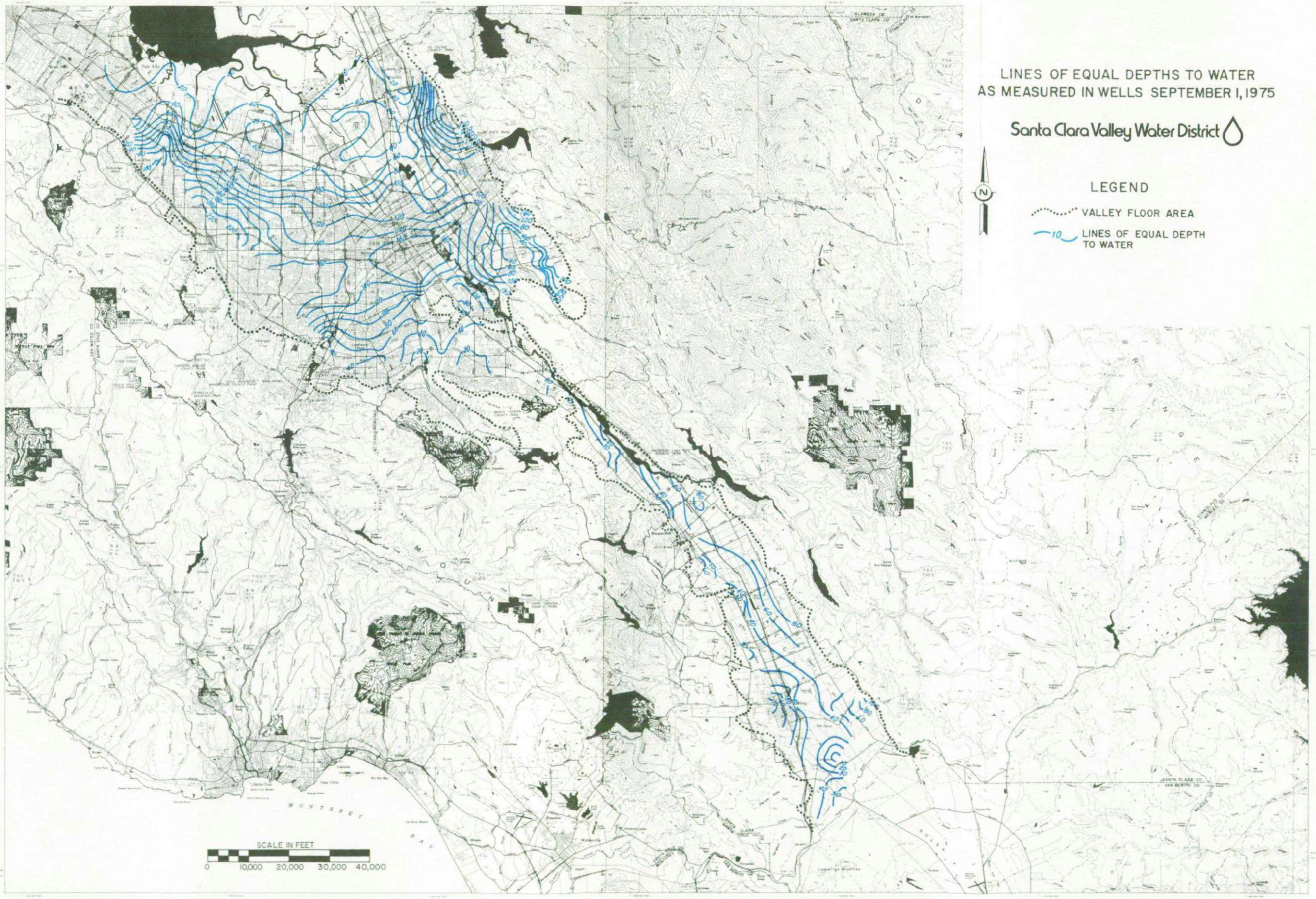

LINES OF EQUAL DEPTHS TO WATER
AS MEASURED IN WELLS SEPTEMBER 1, 1975
Santa Clara Valley Water District
LEGEND
VALLEY FLOOR AREA
10
LINES OF EQUAL DEPTH TO WATER
N
SCALE IN FEET
0
10,000
20,000
30,000
40,000
MONTEREY BAY

PLATE 4

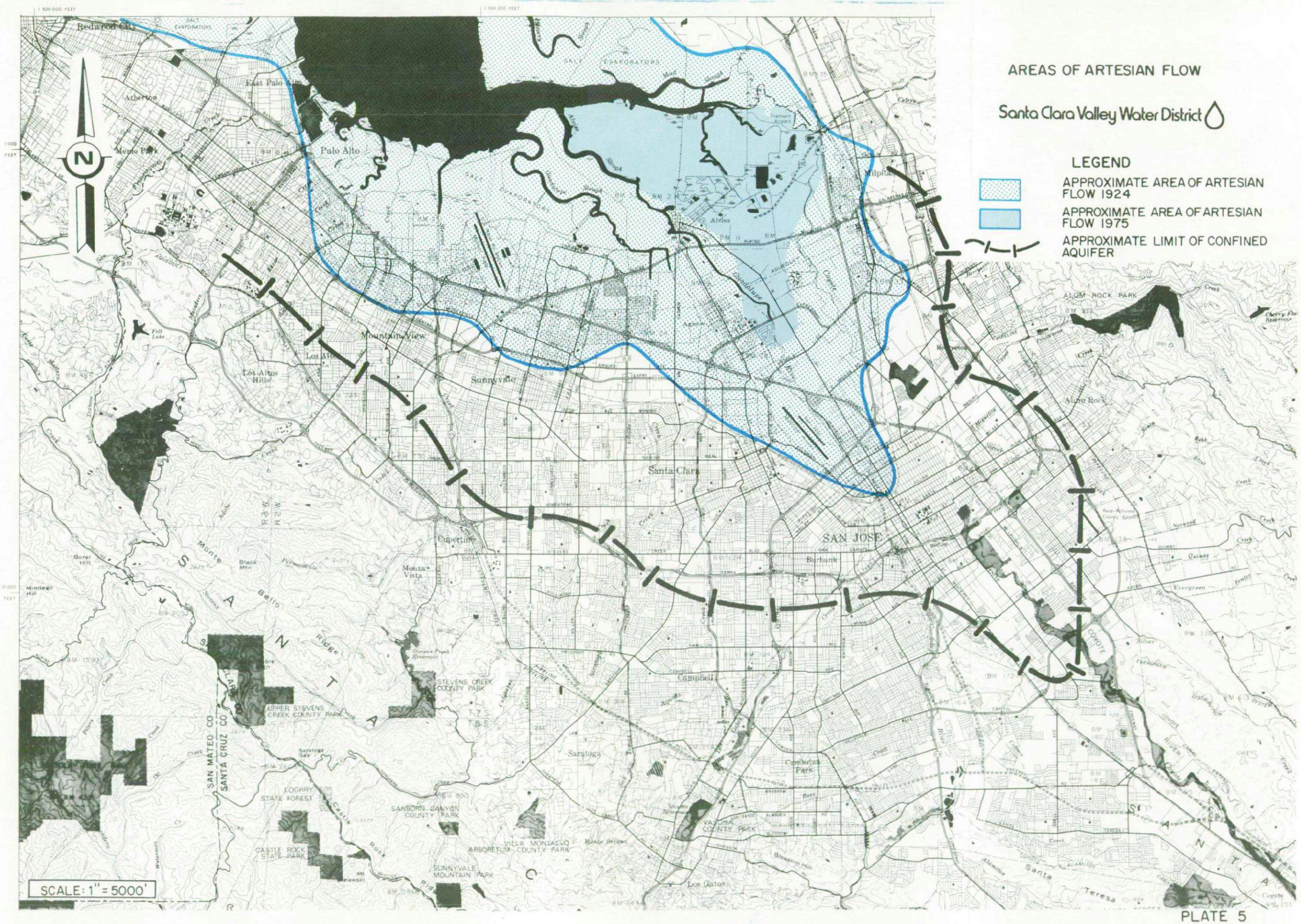

AREAS OF ARTESIAN FLOW
Santa Clara Valley Water District
LEGEND
APPROXIMATE AREA OF ARTESIAN FLOW 1924
APPROXIMATE AREA OF ARTESIAN FLOW 1975
APPROXIMATE LIMIT OF CONFINED AQUIFER
N
SCALE: 1" = 5000'
Redwood City
Atherton
East Palo Alto
Menlo Park
Palo Alto
Milpitas
Alviso
Mountain View
Los Altos
Los Altos Hills
Sunnyvale
Santa Clara
SAN JOSE
Cupertino
Monta Vista
Burbank
Campbell
Saratoga
Los Gatos
Alum Rock
ALUM ROCK PARK
Felt Lake
Borel Hill
Mindego Hill
Black Mtn
Monte Bello Ridge
STEVENS CREEK COUNTY PARK
UPPER STEVENS CREEK COUNTY PARK
LOGHRY STATE FOREST
CASTLE ROCK STATE PARK
SANBORN CANYON COUNTY PARK
VILLA MONTALVO ARBORETUM COUNTY PARK
SUNNYVALE MOUNTAIN PARK
VASONA COUNTY PARK
Cambrian Park
SAN MATEO CO
SANTA CRUZ CO
SANTA CLARA CO
SALT EVAPORATORS
Santa Teresa

PLATE 5

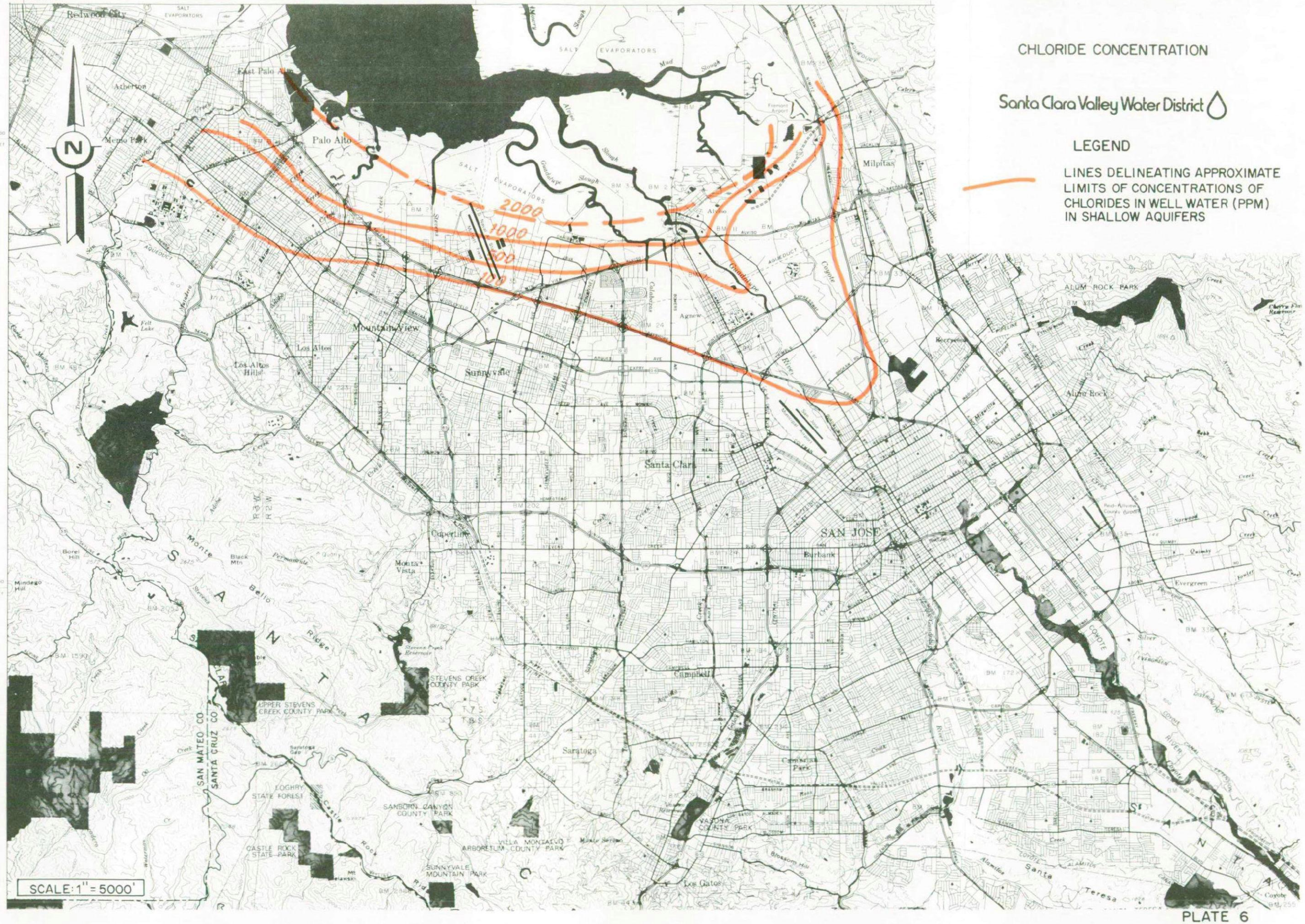

CHLORIDE CONCENTRATION
Santa Clara Valley Water District
LEGEND
LINES DELINEATING APPROXIMATE LIMITS OF CONCENTRATIONS OF CHLORIDES IN WELL WATER (PPM) IN SHALLOW AQUIFERS
2000
1000
500
100
N
Redwood City
East Palo Alto
Atherton
Menlo Park
Palo Alto
Milpitas
Mountain View
Los Altos
Los Altos Hills
Sunnyvale
Santa Clara
SAN JOSE
Cupertino
Monta Vista
Campbell
Saratoga
Los Gatos
Agnew
Berryessa
Alum Rock
Evergreen
Alum Rock Park
Felt Lake
Stevens Creek Reservoir
STEVENS CREEK COUNTY PARK
UPPER STEVENS CREEK COUNTY PARK
LOGHRY STATE FOREST
CASTLE ROCK STATE PARK
SANBORN CANYON COUNTY PARK
VILLA MONTALVO ARBORETUM COUNTY PARK
SUNNYVALE MOUNTAIN PARK
VASONA COUNTY PARK
Cambrian Park
SANTA CLARA
SAN MATEO CO
SANTA CRUZ CO
SALT EVAPORATORS
Mud Slough
Guadalupe Slough
Alviso Slough
Coyote Creek
Santa Teresa
SCALE: 1" = 5000'

PLATE 6